COMPARISON OF TWO COOLING PROCEDURES ON LINEAR DIMENSIONAL CHANGE OF HEAT CURED ACRYLIC MAXILLARY COMPLETE DENTURE BASE

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ABSTRACT

Certain dimensional changes are known to occur in acrylic resin during or after its processing. These changes hold clinical significance because better adaptation of denture base to oral tissues is related to minimum dimensional changes after processing. This study aimed at the evaluation of linear dimensional changes of maxillary heat cured denture bases after bench cooling and rapid cooling procedure . It was a randomized controlled trial , done in Central Dental Laboratory at Armed Force Institute of Dentistry. 60 heat cured acrylic resin (PMMA), maxillary complete denture bases divided into two equal groups (A & B) of 30 each randomly using a scientific random number table were fabricated by passing through standard heating cycle and then the flask cooled by bench cooling method and rapid cooling method for 30 each. Linear dimensional changes from point A to B, A to C and B to C were noted. The study sample were considered to be significant with the p-value 0.003, 0.001 and 0.001 respectively. Bench cooling is a preferable technique to improve the mucosal adaptation of the denture base and less dimensional changes.

Key Words: *Poly methylmethacrylate (PMMA) denture base, polymerization shrinkage, linear dimensional change, Bench Cooling, Rapid Cooling.*

INTRODUCTION

Denture bases are commonly made from acrylic resins, which were introduced by Dr. Walter Wright back in 1937. Among these, polymethyl methacrylate (PMMA) is mostly used.[1-3] PMMA material is mostly processed by wet heat and compression molding techniques, which deliver dentures with acceptable mechanical properties. However, certain dimensional changes are known to occur in acrylic resin during or after its processing.[4] These changes hold clinical significance because better adaptation of denture base to oral tissues is related to better contact between denture base and the cast.[5]

For better adaptation to oral tissues, denture base material must have dimensional accuracy during and after its processing. However, inaccuracies tend to occur due to unavoidable changes during fabrication such as thermal expansion on heating, contraction on cooling and polymerization shrinkage due to release of residual stresses.[6,7] In addition to volumetric shrinkage, linear shrinkage causes significant effects upon denture base adaptation and cuspal interdigitation. The greater the linear shrinkage, the greater is the discrepancy observed in the initial fit of a denture.[8] Such deformities can be overcome or minimized by using different fabrication techniques. Some factors such as cooling procedure of the flask and polymerization method may affect the processing shrinkage. Slow cooling has been recommended to avoid high residual stresses.[4]

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Heat activated PMMA is commonly processed in a brass flask using a compression molding (dough) technique. The polymerization reaction is exothermic. These resins are polymerized by placing the flasks in a time-temperature controlled water bath.[9]

Following completion of the chosen polymerization cycle, the denture flask should be cooled slowly to room temperature. Rapid cooling may result in warpage of denture base because of differences in thermal contraction of resin and investing stone.[8]

In bench cooling, the flask is taken out from the curing chamber and allowed to cool slowly to room temperature. Slow cooling decreases the risk of distortion. The flask is opened only after it has cooled sufficiently. It may be left as such overnight. In rapid cooling, the flask is allowed to bench cool for 30 minutes and then placing it under running tap water for 30 minutes.[10]

The study will compare linear dimensional changes in PMMA edentulous maxillary denture bases between two different cooling methods following a standard curing cycle. Thus ensuring fabrication of a denture base which will have better retention, support, stability and comfortable for the patient gaining patient's confidence.

METHODOLOGY

A dental stone master cast of edentulous maxilla (Fig 1) was obtained from a rubber mold (Silastic RTV; Dow Corning, Columbia City, IN. Fig 2), poured in type III dental stone (Dentamerica) with a mixing ratio of 30mL water to 100g powder according to manufacturer's instructions. A metallic master die (cobalt-chromium, Bego, Germany) of 2 mm uniform thickness (Fig 3) was simulated from the cast obtained containing three metallic projections, one at the center of incisive papilla (point-A) and two at the most bulbous point of tuberosity (point B&C) respectively. The projections will be 0.5mm high and 1.0mm in diameter. This master die served as a wax pattern during the flasking of each specimen. The projections on the metallic framework served as indexes for future measurements and comparison of the processed PMMA denture bases. The casts were numbered. After application of sodium alginate (Separating fluid, Ivoclar AG, Liechtenstein) which was allowed to dry completely, the metallic die was placed over the casts during the flasking of the casts. Once the plaster was set, the metallic framework was removed from the casts carefully.

TABLE 1: DISTANCES FROM POINT A TO B, A TO C AND B TO C ON METALLIC MASTER DIE

Distances	N	Minimum	Maximum	Mean	Std Deviation
Distance from A to B	60	5.10	5.10	5.1000	.0000
Distance from A to C	60	5.10	5.10	5.1000	.0000
Distance from B to C	60	6.80	6.80	6.8000	.0000
Valid N (listwise)	60				

TABLE 2: DISTANCES FROM POINT A TO B, A TO C AND B TO C ON PMMA HEAT CURED MAXILLARY DENTURE BASE BY BENCH COOLING

Distances	N	Minimum	Maximum	Mean	Std Deviation
Distance from A to B	30	4.78	5.20	5.0427	0.0967
Distance from A to C	30	4.87	5.20	5.0610	.1035
Distance from B to C	30	6.29	6.99	6.7987	.1349
Valid N (listwise)	30				

TABLE 3: DISTANCES FROM POINT A TO B, A TO C AND B TO C ON PMMA HEAT CURED MAXILLARY DENTURE BASE BY RAPID COOLING

Distances	N	Minimum	Maximum	Mean	Std Deviation
Distance from A to B	30	4.76	5.38	4.936	.1589
Distance from A to C	30	4.69	5.26	4.947	.1474
Distance from B to C	30	6.60	7.22	6.831	.1852
Valid N (listwise)	30				

TABLE 4: LINEAR DIMENSIONAL CHANGE FROM POINT A TO B (D1), A TO C (D2) AND B TO C ON PMMA HEAT CURED MAXILLARY DENTURE BASE BY BENCH COOLING AND RAPID COOLING

D1	Cooling Method	N	Mean	Std Deviation	Std Error Mean
	Bench cooling	30	0.05733	0.0967	0.0176
	Rapid cooling	30	.1633	.1589	0.0290
D2	**Cooling Method**	**N**	**Mean**	**Std Deviation**	**Std Error Mean**
	Bench cooling	**30**	**0.039**	**.1035**	**0.0188**
	Rapid cooling	30	.1530	.1474	0.0269
D3	**Cooling Method**	**N**	**Mean**	**Std Deviation**	**Std Error Mean**
	Bench cooling	30	1.7390	.1035	0.0188
	Rapid cooling	30	1.8530	.1474	0.0269

t-value = - 3.467
df = 58
P- value = 0.003

The gypsum surfaces was again coated with two thin layers of same sodium alginate which was allowed to dry completely. 30 heat cured acrylic resin (Stellon Manufactured by BD England) denture bases were obtained after standard heating cycle from these casts. PMMA dough was used with a monomer: polymer ratio of 1:3 by volume.

A mixing ratio of 35.5g powder to 15mL liquid was used according to the manufacturer's instructions for each flask pressing. The prepared dough was trial packed in accordance with the group assignments. A plastic sheet was used as a separating medium between the gypsum and the PMMA during the initial flask closure under a load of 850 kilograms-force (kgf). After opening the flask, the plastic sheet was removed, and excess acrylic resin trimmed. Molds were packed by conventional flask pressure technique.

The flasks were placed in traditional spring clamps after final pressing in a hydraulic press (Linea H 2000, SP-Brazil) under a load of 1250 kg for 5 minutes. All specimens were cured at 74°C for 8 hours in an electric curing unit (EVL 5520 manufactured by Kavo Inc West Germany) following two different cooling methods. Group A was allowed to bench cool.

Linear dimensional changes of edentulous maxillary PMMA denture bases (Fig 4) after same heating cycle after bench cooling method measured directly from the reference points (projections in the cured bases) using a vernier caliper (214, Mutitoyo, USA: Fig 5) and was compared with the metallic master die.

Data was analyzed by SPSS version 17. Mean ± S.D will be calculated for distances between points AB, AC and BC for bench cooling (group-A) . 't'-test will be applied for the comparison of linear dimensional changes between points AB, AC and BC in bench cooling (group-A) with the control (metallic master die). A P-value d" 0.05 was considered significant.

RESULTS

(Fig 1)

(Fig 2)

(Fig 3)

(Fig 4)

(Fig 5)

DISCUSSION

This study showed that the linear dimensional change of the specimen, which was bench-cooled and then deflasked at ambient temperature was lower than the specimen, which was rapid cooled allowing the flask to bench cool for 30 minutes and then placing it under running tap water for 30 minutes. Bench cooling method results in less dimensional changes as compared to rapid cooling procedure in complete maxillary heat cured acrylic denture base fabrication advocating its superiority and increased reliability.

Acrylic resins shrink during polymerization, absorb water, and expand slowly over a period of time. The combination of polymerization shrinkage and expansion, which occurs when the acrylic resins are either stored in water or inserted in the mouth, could result in dimensional changes.[11] Polymerization shrinkage causes dimensional change of denture during the processing.[8] Amount of shrinkage is difficult to overcome whereas the initiation points and the direction of polymerization can be controlled.[7] Heat conductivities of dough and mould, the distance from heating or cooling place, and the amount of MMA have influence on the polymerization. There have been many reports on the shrinkage and distortion of acrylic denture base resin.[12]

The same results were shown by Consani et al[6], who showed compared the dentures processed by traditional closure tension system when cooled in the curing water itself or in curing water followed by bench storage for 3 hours. They concluded that there was less dimensional changes when the flasks were cooled in their own curing water and bench-stored for 3 hours.

Kobayashi et al[13] also came up with the similar results, that a gradual cooling course for 12 h or more after processing a heat-activated acrylic denture base is effective for lessening deformation of the prosthesis. Polymerization shrinkage causes dimensional change of denture during the processing. Amount of shrinkage is difficult to overcome whereas the initiation points and the direction of polymerization can be controlled[13]. Heat conductivities of dough and mould, the distance from heating or cooling place, and the amount of MMA have influence on the polymerization. In the case of heat processing, the shrinkage mainly appeared on the point where heat supply was slow.[10,11] Heat-activated acrylic denture-base resin has been used for over half a century for complete-denture fabrication.[8] Even at present, instead of the progress in the development of high-polymer materials, acrylic resin remains the principal choice. However, even with the polymer-monomer mixture method, which was developed for the purpose of minimizing polymerization shrinkage, some warpage after processing is inevitable.[4,5]

CONCLUSION

Significant results of present study revealed that bench cooling technique is a valid, biologically acceptable with better patient adaptability, patient compliance and better outcome. Even with the limitations of this study, it can be stated that the flask should be cooled slowly to room temperature, since the residual internal stresses developed by the thermal shrinkage will be released during the cooling process. Bench cooling is more promising technique with greater patient adaptability.

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